XCal Activities at the University of Michigan

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Abstract

Having intercalibrated the GPM constellation, XCal has focused this year has on intercalibration of the TRMM Era constellation. This poster shows key results from the University of Michigan efforts to intercalibrate the series of SSM/I radiometers.

Introduction

The Special Sensor Microwave/Imager (SSM/I) radiometers onboard the Defense Meteorological Satellite Program (DMSP) satellites provide an overlapping series of observations from 1987 to the present (Table 1). In all, there are 6 SSM/I instruments in the PMM constellation. Recent work [Berg et al., 2018] has provided updated calibration for the entire suite, including improved cross-track bias corrections. These updated data have been used to provide intercalibrated set of SSM/I brightness temperatures (Tb) for PMM which will be released in October (approximate date) through PPS.

Satellite	Start of Operations	End of Operations
F08	July, 1987	December, 1991
F10	December, 1990	November, 1997
F11	December, 1991	May, 2000
F13	May, 1995	November, 2009
F14	May, 1997	August, 2008
F15	December, 1999	Present
TRMM	November, 1997	April, 2015

Table 1. SSM/I and TMI operational Dates. All six SSM/I instruments are used in the PMM constellation.

Intercalibration is performed at both the cold (over ocean) and warm (over rainforests) ends of the Tb range to provide two tie-points for a linear intercalibration [Berg et al., 2016] as a function of observed Tb.

UM Role in SSM/I Intercal

The University of Michigan provides vicarious cold and vicarious warm intercalibration data between the members of the PMM constellation for input to the overall XCal intercalibration offsets. With the most well developed warm-end calibration technique [Yang et al., 2016], the UM data are particularly useful for diagnosing and assessing corrections for calibration issues at warm Tbs. The results shown here focus on UM assessment of the warm Tb calibration and intercalibfration of the SSM/I radiometers.

UM Warm Cal Coverage and Stability

By Using both Tropical and Temperate Rainforests, the UM vicarious warm calibration technique provides a more data for better sampling (Figure 1) and enhanced stability (Figure 2) relative to other techniques which use only Tropical targets. This reduces the uncertainty in the PMM Tb record.

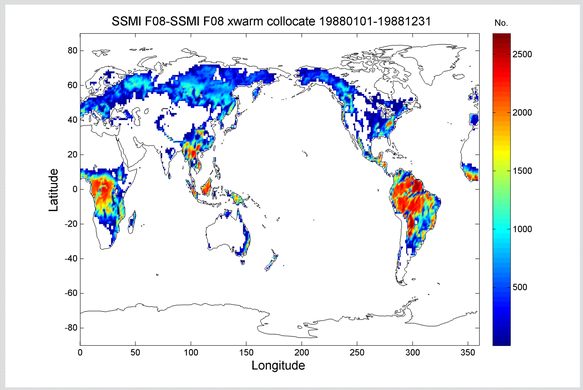

Figure 1. Warm Cal Sampling for UM analysis of 1988 F08 Data. Expanding the range beyond Tropical rainforests increases the coverage, increasing the number of samples and improving the stability of the results. Other instruments/years are similar.

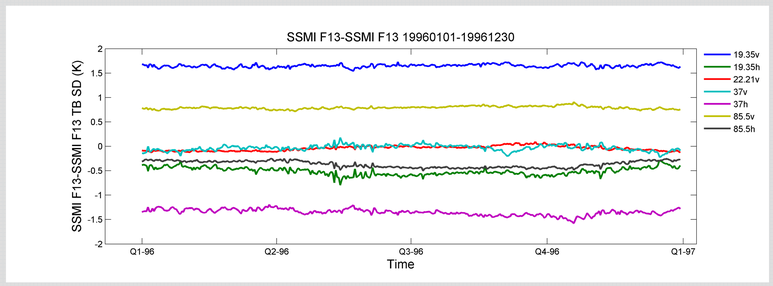

Figure 2. Single Differences (Observed – Simulated Tb) for 1996 F13 Data. The SDs are stable to within <0.1 K over the entire year. Other instruments/years are similar.

SSM/I Cross-Track Bias Correction

Cross-track bias corrections for SSM/I were developed by the XCal group and applied to data by PPS. Using the vicarious warm calibration technique, these data were assessed by UM.

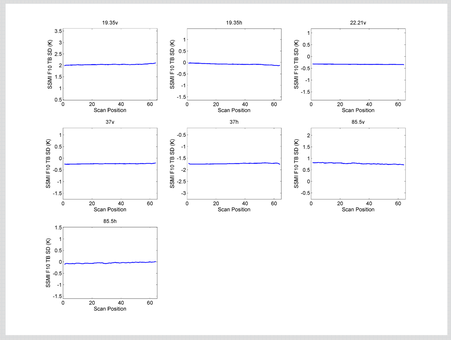

Figure 3. Single Differences (Observed – Simulated Tb) for 1996 F10 Data as a function of scan position. The Xcal developed scan bias correction is working very well. Other instruments/years are similar.

UM Derived SSM/I Intercalibration

The PMM reference for the TRMM Era is the TRMM Microwave Imager (TMI). Because TMI doesn't overlap in time with each of the SSM/I radiometers (see Table 1), the XCal intercalibration results use a combination of "double differences (DDs)" (when there is overlap) and "single differences" (SDs). SDs are differences with respect to simulations, which use ERA-Interim analysis fields, for a given radiometer, while DDs are the difference between the SDs for a given pair of radiometers.

Sat, Year	18V	18H	23V	36V	36H	89V	89H
F08, 88	2.1	0.2	-0.4	-0.5	-1.8	0.5	0.3
F08, 91	1.8	-0.2	-0.4	-0.1	-1.5	--	--
F10, 91	2.0	-0.1	-0.4	-0.2	-1.7	0.7	0.0
F10, 96	2.0	-0.1	-0.3	-0.2	-1.7	0.8	0.0
F13, 96	1.7	-0.5	0.0	0.0	-1.4	0.8	-0.4
F14, 01	1.5	-0.7	0.0	0.1	-1.0	0.7	-0.4
F15, 01	1.5	-0.6	0.0	-0.1	-1.1	0.7	-0.3

Table 2. SSM/I Constellation SDs by channel from UM analysis. These SDs are very consistent from instrument to instrument and year to year.

References

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